Attachment B

Population Size and Complexity: Interior Columbia Chinook and Steelhead ESUs

The intent of this analysis is to develop and apply an approach for characterizing the relative size and complexity of Interior Columbia Basin stream type chinook and steelhead populations based on available GIS data layers and empirically derived fish/habitat relationships. The results will be used by the Interior Columbia Technical Recovery Team to: 1) adapt viability curves (abundance/productivity criteria) to reflect population size, and; 2) contribute to the development of spatial structure/diversity criteria.

Background

One of the major tasks assigned to Technical Recovery Teams (TRTs) is the development of population level viability criteria for the specific Evolutionarily Significant Units (ESUs) within their assigned domain. The Interior Columbia River domain covers seven ESUs previously listed under the Endangered Species Act (ESA). The Interior Columbia Basin TRT has identified the basic population structure of these ESUs in a previous report. The tributary drainages used by populations within Interior Basin ESUs vary considerably in terms of size and complexity. Table B-1 summarizes the range in drainage area associated with Interior Basin ESU populations of stream type chinook and steelhead.

Table B-1. *Relative size (tributary drainage area) of populations within Interior Columbia Basin listed stream type chinook and steelhead ESUs.*

ESU	Extant Populations (#)	Basin Drainage Area	
		Smallest	Largest
Snake River Spring/Summer Chinook	29	130	3,800
Upper Columbia Chinook	3	1,080	4,700
Snake River Steelhead	22	625	6,800
Mid-Columbia Steelhead	16	600	9,600
Upper Columbia Steelhead	3 (+1?)	1,075	4,700

Examples of populations occupying smaller drainages include Asotin Creek and Sulphur Creek (Snake River Steelhead and Spring/summer Chinook ESUs); Rock Creek and Fifteen Mile Creek (Middle Columbia Steelhead ESU) and the Entiat River (Upper Columbia Steelhead and Spring Chinook ESUs). Populations using relatively large, complex tributaries include Upper John Day steelhead, Wenatchee and Methow River steelhead and spring chinook; and Lemhi River steelhead and spring/summer chinook. This natural variation in size and complexity suggests that even historically, populations likely varied in their relative robustness, or resilience to perturbations.

Interior Columbia Basin steelhead and chinook salmon are adapted to take advantage of different types of freshwater habitat. Juvenile densities of both yearling and stream type chinook are typically highest in relatively low gradient, unconfined stream reaches with well defined pool structure (e.g., Hillman& Miller, 2002, Petrosky & Holubetz, 1988). Steeper gradient relatively confined tributary reaches typically support the highest relative densities of juvenile steelhead (e.g., Slaney et al., 1980, Petrosky & Holubetz,1988, Burnett, 2001). Steelhead have also been reported to use braided mainstem reaches for spawning and rearing, given appropriate flow, temperature and substrate conditions (e.g., ODFW, 1972

Direct measures of the productivity of a particular reach in terms of life stage survivals are difficult to generate and are rarely available at fine scales. The following analysis uses relationships between physical watershed characteristics and stream structure derived from the literature to map potential spawning and rearing areas. There are relatively few fine scale studies relating redd densities to stream characteristics. Field studies relating densities of juveniles measured at a consistent life stage to those physical stream characteristics were used to assign relative intrinsic potential ratings to stream reaches. The resulting potential ratings were applied to Middle Fork Salmon reaches and the results were compared with recently derived empirical information on redd densities (Isaac, et al. 2003).

Methods:
The criteria developed in this analysis are based primarily on empirically observed relationships between summer rearing densities of juveniles and physical habitat characteristics. The results of the juvenile based assessments are modified to reflect empirically observed limits to spawner distribution - specifically by a set of minimum criteria for stream width. The resulting habitat ratings are intended to characterize the quantity and the distribution of habitats capable of sustaining both spawning and rearing within Interior Columbia Basin watersheds. This also facilitates comparisons with empirical data on the current distribution of spawners. It is important to recognize that the productivity of spawners in a particular reach can be influenced by rearing conditions in upstream and downstream reaches. For example, stream reaches below the minimum width cutoff associated with spawning may provide important summer rearing habitat for steelhead in a particular tributary.

Steps:

1. Identify criteria for defining upper and lower boundaries to salmon/steelhead production in Interior Basin ESU watersheds.

2. Review available data sets relating simple measures of habitat characteristics to production potential for salmon and/or steelhead and select one or more habitat characteristics representative of high, low or moderate levels of fish productivity.

3. Develop or acquire GIS layers incorporating key habitat measures related to salmon and steelhead production potential for Interior Basin ESU populations.

4. For each population, assign spawning/rearing reaches with respect to salmon and steelhead production potentials - as high, moderate, low, negligible or none.

5. Results were compared against empirical reach specific estimates of relative abundance of spawning adults and specific adjustments to the criteria were incorporated.

6. The amount of habitat by ratings category was summed by population. A soil type/erosion potential screen was applied to exclude low gradient/wide valley (>20 bf width) habitat unlikely to contain spawning gravels. Weighted totals by population (and by subareas within populations) were generated.

Upstream limits on the potential use of tributary habitat for spawning and rearing by salmon and steelhead were defined in terms of stream width and gradient. Minimum stream widths capable of supporting spawning were estimated based on available width measurements for index reaches with documented redd counts and on expert opinion of biologists familiar with Interior Columbia spawning reaches.

For spring chinook, we used two data sets; 1) results from recent USFWS efforts in the Middle Fork Salmon River and a regression model (see below) of stream width at low summer flows; and 2)index average stream widths for Grande Ronde spawning reaches to estimate the minimum stream width associated with spawning. For steelhead, we used John Day index area redd count data, O. mykiss (juvenile?) presence/absence data from ODFW, and IDFG transect parr count data sets from the Salmon and Clearwater basin. In both the spring chinook and steelhead analyses, we took the 95th percentile low value for bankfull and wetted width to delineate our upstream extent. Use of smaller tributaries for juvenile rearing has been documented (e.g., Nez Perce tribal comment letter). Spawning in smaller tributaries may occur in particular situations.

Reaches above gradient barriers were also excluded as production areas. A slope of greater than 20% within a 200 meter reach was defined as a gradient barrier to steelhead spawning. Stream reaches with gradients above 5% were also excluded as spawning/rearing areas based on expert opinion and on a review of index reach data sets for Interior Basin streams.

The lower reaches of many interior basin tributaries are subject to relatively high summer temperatures - well above levels injurious to salmon and steelhead. Current temperature regimes are significantly influenced by human activities for many interior drainages. There are relatively few specific analyses of historical temperature regimes for Interior Columbia basin drainages. Persistent high temperature levels can have a significant impact on the ability of a given reach to sustain juvenile rearing and adult spawning. We adopted the temperature criteria used by

Chapman & Chandler (2001) - weekly mean average temperature (WMAT) exceeded 22 degree C - to identify situations where temperature could potentially limit or exclude salmon and steelhead production. *Note: the initial set of variables used in this analysis do not reflect the effects of groundwater on ameliorating temperatures in mainstem reaches with broad, alluvial flood plains (e.g., lower Yakima).*

Parr Density Data
In the early to mid 1980's, IDFG biologists compiled a baseline data set for evaluating the effectiveness of habitat improvement projects. The data set included both measures of parr densities (chinook and steelhead/rainbow trout) and habitat measures. The study concluded that chinook parr densities were the highest in low gradient stream sections in relatively wide valleys and that steelhead/rainbow juvenile densities were the highest in steeper gradient, more confined reaches (e.g., Petrosky & Holubetz, 1988). Maximum parr densities were also influenced by sediment levels. The original analyses focused on data collected in years with relatively high parental escapements to minimize the confounding effect of relatively low seeding (Petrosky and Holubetz, 1988). We used data from naturally seeded areas from that parsed data set for the current analyses. For each species, parr densities were plotted against gradient and stream width within two valley width categories corresponding to B channel and C channel designations (Rosgen, 1985) used in the original study. Wider stream reaches known to be used for spawning and rearing by steelhead were not well represented in the Idaho baseline study. A second data set, compiled by the Washington Department of Game for larger rivers in western Washington and Puget Sound, was also analyzed to provide some insight into production relationships in larger systems.

Adult Spawner Distributions
We incorporated the results from multi-year chinook redd surveys conducted by the USFWS within the Middle Fork Salmon River into our intrinsic potential analyses. Those results were used to corroborate the relative ratings developed based on parr density data sets for smaller streams, and to facilitate expanded application to wider (> 10 m bankfull width) stream reaches. The USFS Middle Fork chinook redd survey results identify the specific spawning locations of individual redds on a relatively fine scale compared to most survey data sets, and the surveys consistently covered a wide geographic area (multiple populations). In their project, comprehensive aerial counts were completed for chinook streams during spawning season and individual redds were coded with GPS coordinates. From their efforts, we georeferenced each data point using its GPS location and combined all into a GIS data layer representing the complete spatial and temporal distribution for observed chinook redds within the Middle Fork.

Using the georeferenced redd coverage, we then completed a proximity analysis with our 200-meter reach segments containing modeled stream characteristics. By identifying the nearest stream reach to individual redds, we successfully quantified the total number observed per 200-meter segment. These results enabled us to relate redd densities to the stream metrics contained within the reach theme, including gradients, widths, and confinement parameters. The comparison of chinook use to stream characteristics allowed us to determine preferred habitats and develop classification schemes for intrinsic spawning potential throughout our study area.

Spawning/Rearing Production Criteria

Four different habitat measures were used to define a set of criteria for estimating reach specific production potential for stream type chinook and steelhead using interior Columbia basin tributary habitats. The four habitat criteria selected were stream width (estimated or measured as bankfull width), stream gradient (percent change in elevation over reach), valley width (relative width of valley associated with a stream reach) and riparian vegetation. Results from the analysis are summarized by species in Tables 2 and 3.

Stream width (bankfull width and wetted widths) Three stream width categories were established based on an examination of the data sets; 3 to 25 m, 25 - 50 m and >50 m. Streams less than 3 m in bankfull width were at the lower margins sampled in the Idaho baseline study. As a result, initial potential analyses assumed that streams less than 3 m would not sustain rearing and spawning for both stream type chinook and steelhead. Presence/absence data provided by the Nez Perce Tribal staff indicates that some streams less than 3 m support production (at least seasonally) for steelhead. No specific data were provided to identify an alternative cut-off width. WDFW has recommended using 2 m wetted width as a lower limit for steelhead in western Washington streams (reference). ODFW has compiled extensive steelhead spawning ground surveys for the John Day basin, including associated wetted widths for index reaches. 41 out of 43 of the reaches had recorded widths above 2m. The WDG study included mainstems up to 50 m in width. Steelhead parr densities at gradients exceeding 1.0 remained at relatively high levels in the widest streams.

Based on these analyses, we set lower limits relative to spawning/rearing potential of 3.6 m (wetted width) for chinook and 3.8 m (bankfull width) for steelhead, respectively. Spring chinook spawn in the late summer and early fall, summer wetted width is an appropriate measure of stream size relative to this time period. Steelhead spawn in the late spring on the end of the spring freshet, bankfull width is a more appropriate measure of stream size relative to this period.

Valley width. The Idaho baseline study classified streams as B type or C type channels using criteria proposed by Rosgen (1985). Given the intent to develop criteria that could be applied using a GIS analysis, we developed a specific measure to use in defining a particular area as if valley width exceeded 20 times bankfull width at the midpoint of a stream segment it was classified as a C channel type. Streams characterized by bankfull width less than 100 m were treated in a separate category and assumed to be B type.

Highly confined moderate to high gradient reaches are unlikely to exhibit the general stream structure associated with salmon and steelhead spawning. We incorporated a measure of minimum valley width into our set of criteria for assigning intrinsic potential ratings to individual stream reaches. Streams that have a valley width to bankfull width ratio of less than 4.0 are highly confined with virtually no opportunities for flood plain structure (e.g., Hall et al.

in press). Higher gradient confined streams are more likely to lack instream structure conducive to salmonid spawning. If the valley width associated with a particular stream reach was less than 4 times the bankfull width of that reach, the intrinsic production potential rating was downgraded by one classification level.

Gradient: A set of gradient categories was developed based upon the Puget Sound TRT chinook matrix (e.g., Table 2 in WRIA 18 Draft Summary Rept - Puget Sound Chinook Recovery Analysis Team) and the categories used in the Idaho and Washington Game Dept. studies. For chinook, most of the observed parr density/stream gradient data pairs fell within the 3 to 25 m streamwidth category (Figure 1). In general, densities were relatively high at gradients below 1.0 to 1.5 % gradients. Although observations were relatively sparse, densities were relatively low at gradients exceeding 1.5 to 2.0 percent. The frequency of samples exhibiting low pool cover (less than 50%) increased rapidly as gradients exceeded 1.5%.

Steelhead/rainbow exhibited the reverse pattern with relatively low densities at gradients below 0.5, increasing as gradients increased to approximately 4% (Figure 2). Steelhead parr densities remained relatively high as gradients increased above 4%. We assigned the highest potential rating to gradients between 4% and 7% (upper limit consistent with expert opinion cited in the draft Lower Columbia/Willamette TRT Viability report). Stream reaches in the 3.8-25 m bf width category that had gradients between 7 and 15% were designated as Low. No spawning potential was assumed if gradients exceeded 15%.

Interior Columbia basin summer steelhead have been documented spawning in stream reaches exceeding 25 m bankfull width. Stream widths greater than 20 m bankfull width were not well represented in the parr transect data sets we used to set relative productivity levels for different gradient classes. We assigned tentative spawning/rearing potential ratings to each gradient class based on the limited parr data, augmented by parr data sets collected in western Washington river systems. In general, potential ratings were reduced one level for a given gradient category.
We used adult steelhead spawner distribution data to augment the parr data analyses in determining relative ratings for streams exceeding 25 m bankfull width. We analyzed the distribution of steelhead spawners vs width and gradient classes using index survey data sets for the John Day and Klickitat River systems, and using radio tracking results for Yakima steelhead (Hockersmith et al., 1995). The results generally comported with our assignments of relative productivity.

Riparian vegetation: One additional modifier was incorporated into the framework based on the Puget Sound chinook example. Pool structure in Puget Sound was affected by the availability of large woody debris. It was not possible to evaluate the potential linkage with riparian cover with the Idaho parr density/habitat baseline data base. Initially, we included the assumption that the availability of LWD from adjacent riparian areas (where designated as Mesic forest or similar classifications) would result in increased pool structure in moderate gradient reaches. Analysis of the USFWS Middle Fork adult redd data set did not support increased production potential (redd densities) in Mesic forest vs non -forested reaches in relatively confined reaches. As a result, we dropped this rating category from our analysis.

Sedimentation. The ability of a particular reach to support salmonid spawning can be significantly affected by sediment conditions within that reach e.g., Bjornn and Reiser, 1991). Relatively low gradient stream reaches meandering through wide valleys can be deposition areas for fine sediments, especially if the surrounding soil types are highly erosive and fine grained. We used available GIS layers summarizing soil characteristics to assign relative indices of erosion potential and particle size to each tributary reach. The indices were calculated as an average across the HUC-6 corresponding to each particular stream reach.

Stream sedimentation is often a critical factor limiting the spatial distribution of salmonid spawning. In riverine systems, certain environmental traits promote the accumulation of stream sediments that can obscure suitable substrates. Specifically, the deposition of fine particles within streams is effected by factors such as soil type and hydrological conditions. In our analysis, these attributes were employed in order to determine where sedimentation might influence salmon and steelhead production. Most crucial to our investigation were the identification of highly erodible soils and low gradient streams which maximize particle detachment and limit transport.

Two primary data sources were utilized in our effort to locate probable sedimentation: the USDA-NRCS STATSGO soil survey, and reach level gradients obtained from USGS DEMs. The STATSGO dataset contains a measure of potential erodibility, or K factor, which is a predictive measure (0.0 – 1.0) of particle detachment resulting from rainfall. Soil texture and permeability are the key factors in determining the K factor, with clays having the lowest value (least erodible) and silts having the highest (most erodible). The USDA-NRCS considers soils with a K factor greater than 0.40 to be the most highly erodible and prone to runoff. Soils in this category are predominately composed of silts and silty loams. It should be noted that K factor is a measurement for bare soil conditions, and our analysis is for intrinsic habitats. However, natural disturbances would likely aid in the process of sedimentation more readily in soil units with the greatest erosion potential.

In addition to soil erodibility, we utilized stream gradients as a measure of depositional potential. Gradients were calculated for all 200-meter reaches within our study area using the minimum and maximum elevation per reach as obtained from the USGS DEMs. Low gradient streams result in lower flows and reduced stream power, which in turn promotes depositional rather than transport processes.

In order to determine stream reaches most at risk for sedimentation, we developed a habitat screening mechanism based on K factor and gradient. We first selected low gradient streams ($\leq$ 0.5%) and then intersected these results with soil units having a K factor greater than 0.4. Also, we identified subwatersheds having at least 50% of their area within highly erodible soils ($K >$ 0.4). Low gradient reaches within these watersheds and those intersecting highly erodible soil units were eliminated from habitat summaries. The new output resulted in a diminution of total intrinsic potential in many salmonid populations, but only reduced branch and MSA criteria for chinook populations since the lowest gradient streams correspond to low steelhead intrinsic potential.

Our sedimentation screen relies primarily on adjacency in order to determine effects, and probably results in an underestimation of sediment production and accumulation. A more comprehensive analysis of contributing upstream soil units into stream reaches would be necessary to expand screening capabilities. However, our efforts are meant to highlight the reaches most likely to exhibit sedimentation limitations, and a reduced potential for salmonid spawning.

Relative Densities

The intrinsic potential ratings described above were applied at the 200 m reach scale. For chinook we relied on the Idaho parr data set and the Middle Fork Salmon GIS reference redd data set described above to determine the relative production potential associated with specific combinations of the habitat measures described above. Using the georeferenced redd coverage, we then completed a proximity analysis with our 200-meter reach segments containing modeled stream characteristics. By identifying the nearest stream reach to individual redds, we successfully quantified the total number observed per 200-meter segment. These results enabled us to relate redd densities to the stream metrics contained within the reach theme, including gradients, widths, and confinement parameters. The comparison of chinook use to stream characteristics allowed us to determine preferred habitats and develop classification schemes for intrinsic spawning potential throughout our study area.

Specifically, in order to compare observed Middle Fork redd locations to reach attributes, we categorized stream metrics into discrete codes detailing unique combinations of habitat parameters. These included three groups of bankfull width, 7 gradient classes, and 3 confinement codes. These classification schemes were then summed by total chinook redds observed within each group. An ANOVA was completed that compared the total redd counts to each unique reach metric code, and the results showed significant differences between groups. The outcome from this analysis became an important component for our assessment of intrinsic spawning potential

Using the results from the ANOVA, the greatest mean redd count for a habitat category was assigned a "high" intrinsic spawning potential. This group represented the most preferred habitat by observed chinook spawners in the Middle Fork Salmon River. Any grouping whose mean redd count was at least fifty percent of this highest value was also attributed with a "high" intrinsic potential. Continuing, those categories receiving between 25% and 50% of the highest value were given a "moderate" rating, between 12.5% and 25% a "low" rating, and less than 12.5% a "negligible" rating. These values were then used to weight potential habitat (for both area and length) so that a "high" rated reach was multiplied by 1.0, "moderate" by 0.5, "low" by 0.25, and "negligible" by 0.0. Functionally, the "negligible" category had the same effect on total habitat as inaccessible areas or those failing to meet our minimum width criteria (which were assigned a "none" rating). Neither the "none" or "negligible" classification contributed habitat, in terms of weighted length or area, to the total intrinsic spawning potential per population. Figure 3 illustrates an analysis comparing confinement codes to chinook redd densities in the Middle Fork.

The resulting intrinsic potential rating were summarized at the HUC-6, (subwatershed), MSA/mSA (major/minor spawning aggregation) and population level. The metrics used included total stream km by category/species, total m2 by category/species, and a weighted index of relative capacity. The weighted index was generated by assigning a relative rating to each general category – high, medium and low. Units of habitat rated with high production potential for a species were given a weight of 1. Units of medium production potential were given a relative rating of 0.5 and habitat units classified as low production potential were assigned a relative rating of 0.25. For chinook populations, some reaches were rated as negligible. For the purposes of this analysis those reaches were assigned a weight of 0. A relative index of productivity for aggregate areas was calculated by summing the weighted total amounts of habitat within each category within the appropriate geographic units. The ratios of 1 to .5 to .25 for high, medium and low intrinsic potential categories reflect the patterns observed in the WDG steelhead parr density study (Gibbons et al., 1985, table 6) and are generally consistent with relative densities reported for spring chinook late fall parr in the Idaho studies.

Table B-2. Relative productivity as a function physical stream reach characteristics. Bankfull stream width (BF), stream gradient (percent change over 200 m reach) and valley width (expressed as ratio to BF stream width).

Stream width/ Gradient Categories		**Valley Width**	
	Less than 4 X BF	**>4 and < 20 X BF**	**> 20 X BF**
BF 3.8 to 25 m			
0 to 0.5	Medium	High	High
.51 to 1.5	Low	Medium	High
1.51 to 4.0	Low	Low	Medium
4.1 to 7.0	Negligible	Low	Low
> 7.0	Negligible	None	None
BF 25 m to 50 m			
0 to 0.5	Negligible	Medium	Medium
.51 to 4.0	Negligible	Negligible	Negligible
> 4.0	Negligible	None	None
BF > 50 m	Negligible	None	None

Table B-3. . *Intrinsic potential ratings as a function of stream width (bankfull width), Valley width (ratio to bankfull width) and gradient for Interior Columbia basin STEELHEAD populations*

Stream width/ Gradient Categories		**Valley Width** **< 20 X BF**	**> 20 X BF**
BF 3.8 to 25 m			
0 to 0.5		Low	Low
0.51-1.5		Medium	Medium
1.51 - 7.0		High	High
7.0 -15.0		Low	Low
> 15.0		None	None
BF 25 m to 50 m			
0 to 0.5		Low	Low
.5 to 4.0		Medium	Medium
> 4.0 -15.0		Low	Low
15.0		None	None
BF > 50 m		None	Low

Figure 1. Idaho Spring/Summer Chinook. *Juvenile densities vs. stream gradient for naturally seeded baseline monitoring areas in the Salmon and Clearwater River systems. Parsed data set- low seeding years not included (Petrosky and Holubetz, 1988). Dotted lines indicate assigned category boundaries.*

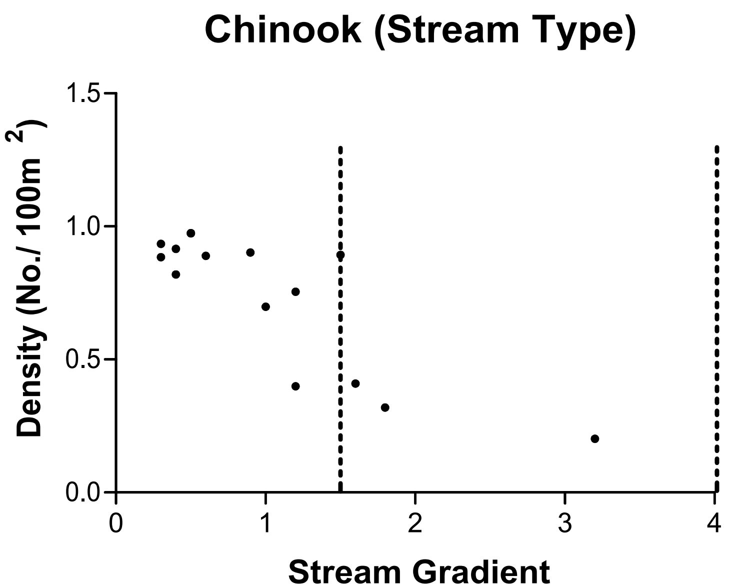

Figure 2. Idaho Steelhead. *Juvenile densities vs. stream gradient for naturally seeded baseline monitoring areas in the Salmon and Clearwater River systems. Parsed data set- low seeding years not included (Petrosky and Holubetz, 1988). Dotted lines indicate assigned category boundaries.*

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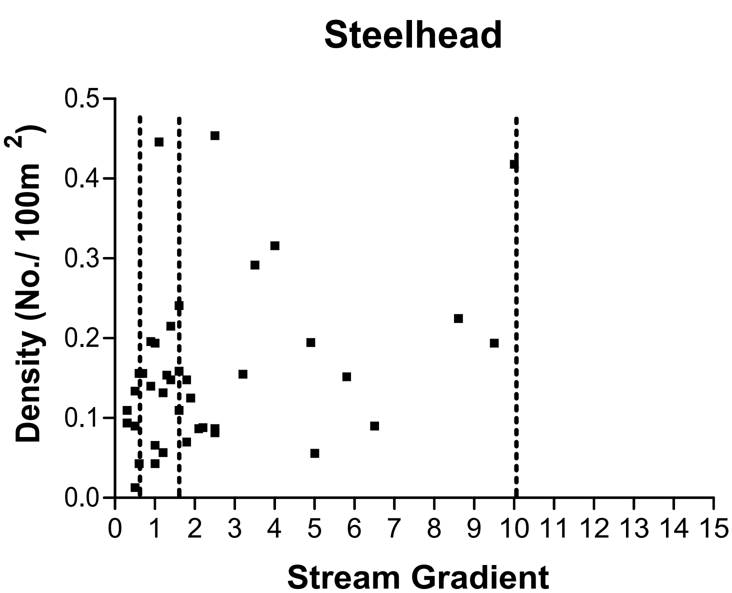
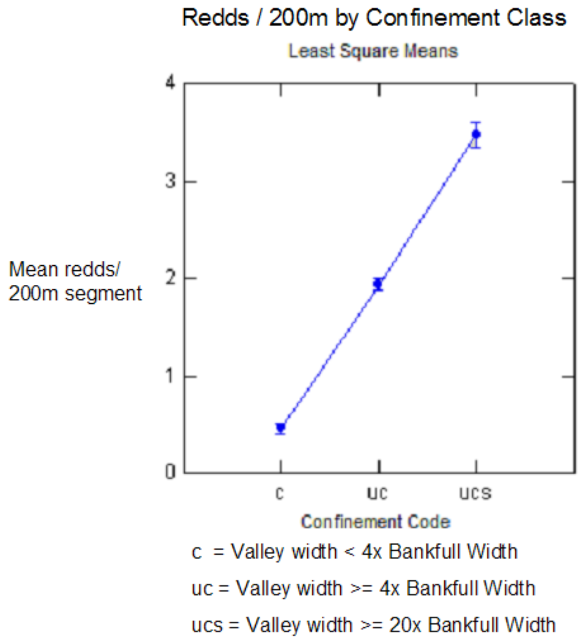


Figure 3. Comparison of spring chinook redd densities (average per 200 m segment) with valley confinement classification.



***Weighted spawning kilometers within a population area will be the metric used for categorizing the relative size and complexity of populations within Interior Basin ESUs*.**

Each of the metrics described above provides useful insights regarding potential population size and complexity. Measures of rearing capacity can be used in assessments of the potential effects of habitat changes (e.g., historical to current) on stock production and abundance. An estimate of potential stream kms of spawning area is particularly relevant measure for use in expressing the size of specific populations relative to abundance/productivity criteria. A strong tendency for returning spawners to home back to natal spawning areas is a general characteristic of chinook and steelhead. The predominant life history patterns for both of these species involve a year or more freshwater rearing, generally in the natal tributary. Returns to particular spawning reaches are therefore largely dependent upon the production from the previous generation of spawning in that same reach. As a result, the availability of suitable quantities of high quality rearing habitat also affects production and therefore average abundance associated with a particular spawning area.

Major Spawning Area: Habitat Required to Support 500 Spawners
Tributary habitats associated with specific Interior Columbia Basin stream type chinook and steelhead populations varied considerably in size and complexity (see above). Within population spatial structure is an important consideration in assessing risk levels relative to localized (watershed level) catastrophic events. In addition, the presence of multiple, relatively discrete spawning areas within a population can increase the potential for development and expression of within population phenotypic and genotypic diversity. The relative size of discrete spawning areas within the tributary habitat used by a particular population is an important consideration. The ICTRT developed the following estimate of the minimum amount of tributary spawning habitat needed to support 500 spawners as a metric for use in characterizing within population spatial structure. Populations that include multiple, relatively discrete areas each capable of sustaining 500 or more spawners are hypothesized to be at less overall risk than populations with one such spawning area.

Spring chinook: At an average of 20.7 redds per km and assuming 2 spawners/redd, 12 km of index reach type habitat would be required to sustain 500 spawners at relatively high spawning densities, 6 km to support 250 spawners.

Steelhead: Given an average of 8.3 redds per km and 2 spawners per redd, 30 km of index reach type habitat would be required to support 500 steelhead spawners at relatively high spawning densities, 15 km to support 250 spawners at relatively high spawning densities

Stream Type Chinook
Estimates of intrinsic potential spawning habitat were generated for 35 populations of Interior Basin stream type chinook from the Upper Columbia and Snake River ESUs. Populations were tabulated in order of estimated total weighted stream kms of rearing habitat. The relative increase between sequential pairs of populations in the size ordered list was calculated. Four general groupings of populations were identified based upon relatively large increases in weighted spawning habitat between adjacent pairs of populations (Figure 1). The relative complexity of populations, measured in terms of the number of Major Spawning Areas, increased over the four size categories (Figure).

<u>*Tributaries Supporting Two Chinook ESUs*</u>
The intrinsic potential analysis described above is based on general physical requirements for chinook spawning and early rearing. Some population areas in the Interior Basin support more than one chinook ESU. We adjusted the total area assigned to the listed spring chinook population in accordance with the following observations.

Upper Columbia Spring Chinook
Each of the extant populations of upper Columbia spring chinook is associated with a population of summer chinook. With the possible exception of the Entiat, summer chinook runs are believed to have been endemic to each system. Upper Columbia River summer chinook are classified in a separate ESU. There are significant differences in life history patterns between the two ESUs - summer chinook return to the Columbia River primarily in July and August, spawn approximately 1 month later than spring chinook, and leave their natal tributary for the mainstem during the summer of their first year of life. Summer chinook spawn later and lower down in the mainstems of the major Upper Columbia tributaries. Gradient and substrate characteristics of stream habitat within the stream sections used for spawning.is similar for both runs. There is some overlap in each system between the lower end of the spring run spawning and the upper end of summer chinook spawning.

In the Methow basin, summer chinook spawning is confined to the mainstem Methow River below the Chewuch River confluence (Anon., 1998). Chapman et al. 1994 states that summer/fall chinook utilize the lower 50 miles of the Methow River mainstem. In the Okanogan, summer chinook currently spawn between Zosel Dam and the town of Mallott and from Enloe Dam to Driscoll Island.

Chapman et al. 1995 summarizes information on spawning timing for summer/fall chinook in the Wenatchee, Methow and Okanogan basins. Methow and Wenatchee - spawning begins weeks 38-39 (late September). Okanogan - weeks 39-41. Late sept early oct). Cites difference may be related to water temps. Peak spawning similar among basins (wks 41-44). Prior to 1980, peak spawning was approx 1 week later, also spawning has ‘moved’ upstream n the Wenachee over the last 30 years. Methow, initial spawning is between Carlton and Winthrop (rm 27-51.6), moving downstream to include area between 12 and 27.2. In the Okanogan, early spawners are above rm 40.

Snake River Spring/Summer Chinook
There is limited potential for overlap in spawning/rearing areas among ESUs of chinook in the Snake Basin.

Tucannon River: Currently, fall chinook use the lower 10 km of the Tucannon mainstem for spawning (redd survey data summarized in Milk et al, 2005). Spring chinook spawning currently occurs in the mainstem from the mouth of Sheep Cr. (rm 52) downstream to King Grade (RM 21) - draft Lower Snk Recovery Plan p 82). The Tucannon system has been heavily impacted by human activities, resulting in increased stream temperatures and high sedimentation rates. Theurer, et al1985 estimated the relative change in summer high instream water temperatures under current and historical conditions. Currently, July average water temperatures exceed 22 deg. C in the lower 50+ km of the Tucannon mainstem. Projections of historical temperatures indicate almost all of the mainstem Tucannon would have had average July temperatures below 22 deg. C.

Spring/Summer Chinook Size Groups

Basic Size Group: Chinook
A group of the smallest populations was identified based on a relatively large gap in relative size between the estimates for the Entiat and Chamberlain Creek populations. The median estimate of weighted historical spawning area for this category was 200,000 sq meters. Populations in this grouping were relatively simple in terms of spatial structure (Table B-2).

Intermediate Size Group: Chinook
A grouping of 11 populations of intermediate size and complexity was defined by the breakpoints separating the groups of smaller and larger populations. The proportional range in population size within within each of the three groupings was relatively consistent - with populations varying in size by roughly a factor of 2 (Table 2).

Large Size Group: Chinook
Eight extant spring/summer chinook populations were identified in a third grouping, the Large population size category. The median size (based on estimated historical potential) of populations in this group was roughly twice the median for the Intermediate group. Populations in this grouping were also relatively more complex – the median number of Major Spawning Areas for populations in this group was 3 compared to a median of 1 for the Intermediate grouping.

Very Large Size Group: Chinook
The four largest populations were assigned to this grouping. The principle difference between populations in this grouping and those in the Large group was overall size (weighted spawning area). The median size of populations in this group was twice that of the populations in the Large grouping. The median number of MSAs was the same as that for the Large grouping.

Figure 1 Interior Columbia Basin Stream Type chinook populations. *Ordered by intrinsic potential (km of weighted spawning/rearing habitat. Bar patterns indicated groupings (Basic, Intermediate, Large, Very Large).*

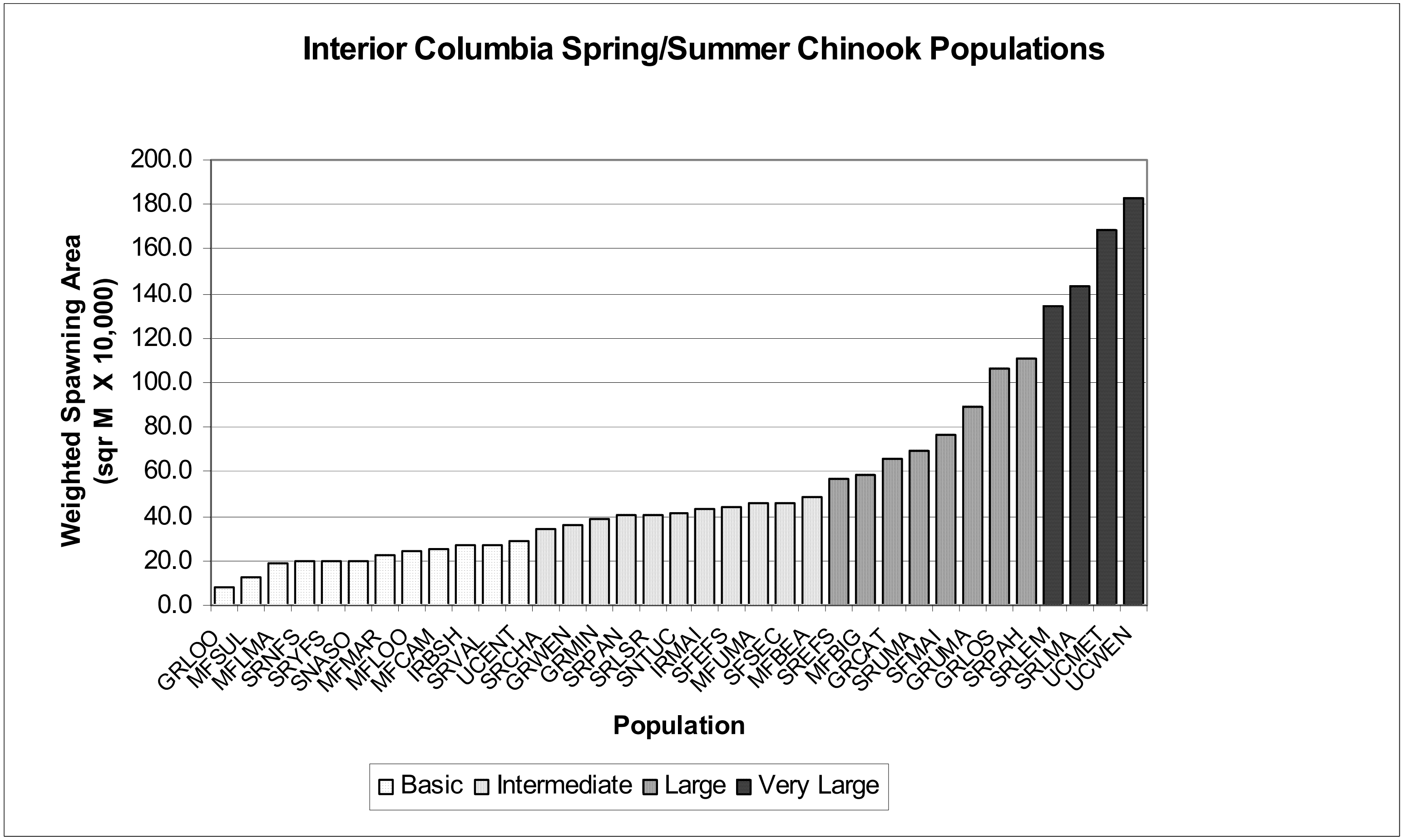


Table B-2 Stream-type Chinook populations (Upper Columbia Spring and Snake River Spring/Summer ESUs). *Summary statistics for population size and complexity assessments. Estimates based on historical intrinsic potential analysis.*

Stream Type Chinook Populations	**Tributary Spawning Habitat - Capacity Categories**			
	Basic	***Intermediate***	***Large***	***Very Large***
Number of Populations in the category	**12**	**11**	**8**	**4**
Spawning Area (X 10,000 m2) ***Median***	***20.0***	***41.6***	***76.8***	***156.1***
Range	*(7.8 - 29.6)*	*(34.3 - 48.9)*	*(57.0 - 110.9)*	*(134.6 - 182.8)*
Number of Major Spawning Areas per population ***Median***	***0***	***1***	***3***	***3***
Range	*(0 - 1)*	*(1 - 3)*	*(1 - 4)*	*(3 -5)*

Steelhead

Steelhead tributary population areas were generally larger than the areas associated with spring/summer chinook, reflecting the wider range of spawning conditions characteristic of steelhead. We identified four groupings of steelhead populations were based on 'breaks' in the cumulative size distribution across the forty seven population's incorporated into the analysis of historical potential. The four size groupings were generally reflected in our basic measure of within population spatial structure – the number of MSAs. (Figure 2; Table 4).

Basic Size Group: Steelhead

A grouping of 7 relatively small populations with relatively simple spatial structure was defined by a break in the cumulative size distribution between estimates of the weighted historical spawning area for the Entiat River and the White Salmon River (extirpated) populations. The Major Spawning Area analysis indicated that populations in this group had relatively simple spatial structure. The median number of MSAs per population in the grouping was 1.

Intermediate Size Group: Steelhead

This size grouping included 24 extant steelhead populations. The upper size boundry for this grouping is defined by the relatively large difference ins size between the Snake River Upper Mainstem and next populations in the sequence, the Upper Middle Fork (Salmon River). The median population size in this grouping is the equivalent of 300 km of spawning/rearing habitat.

Large Size Group: Steelhead

A grouping of relatively large, spatially complex populations was defined based upon a relatively large gaps in population size. The John Day North Fork population was the largest population in this grouping. The median population size for this grouping was roughly twice the median size for the Intermediate group. The 12 populations in this grouping are characterized by relatively high spatial complexity – the number of MSAs per population was 6.

Very Large Size Group: Steelhead

This four largest steelhead populations were assigned to this grouping. The median size of populations in this grouping was half again the median for populations in the Large size category. The median number of MSAs identified for populations in this grouping was 11, almost twice the median for the Large grouping.

<u>Other Considerations</u>

The population groupings were based on physical measures of habitat - stream gradient and width were the determining factors for steelhead spawning potential. Other factors can substantially affect the relative productivity of a particular reach or watershed including temperature conditions and aquatic productivity. We do not have a comprehensive data set representing historical (pre 1850) stream temperatures for Interior Columbia tributaries. We used regression models based on available stream temperature-elevation data to characterize reach specific temperature regimes. Those projections reflect the factors driving stream temperatures during the periods of observation and are not necessarily representative of historical conditions. However temperature mapping based on those relationships can be used to identify populations that are subject to relatively high stream temperatures during key rearing (and spawning periods). The intrinsic spawning or rearing potential estimates for populations exhibiting relatively high potential temperature impacts should be validated using alternative information wherever possible.

Incorporating a summer temperature maximum constraint (weekly maximum less than 22 deg. C) substantially reduced the estimated amount of spawning habitat for many Mid-Columbia ESU and lower Snake River steelhead populations (Table 5). In most cases the reductions in spawning area were associated with lower Mainstem small tributaries.

Figure 2 Interior Columbia Basin Steelhead populations. Ordered by intrinsic potential (km of weighted spawning/rearing habitat). Bar patterns indicated groupings (Basic, Intermediate, Large)

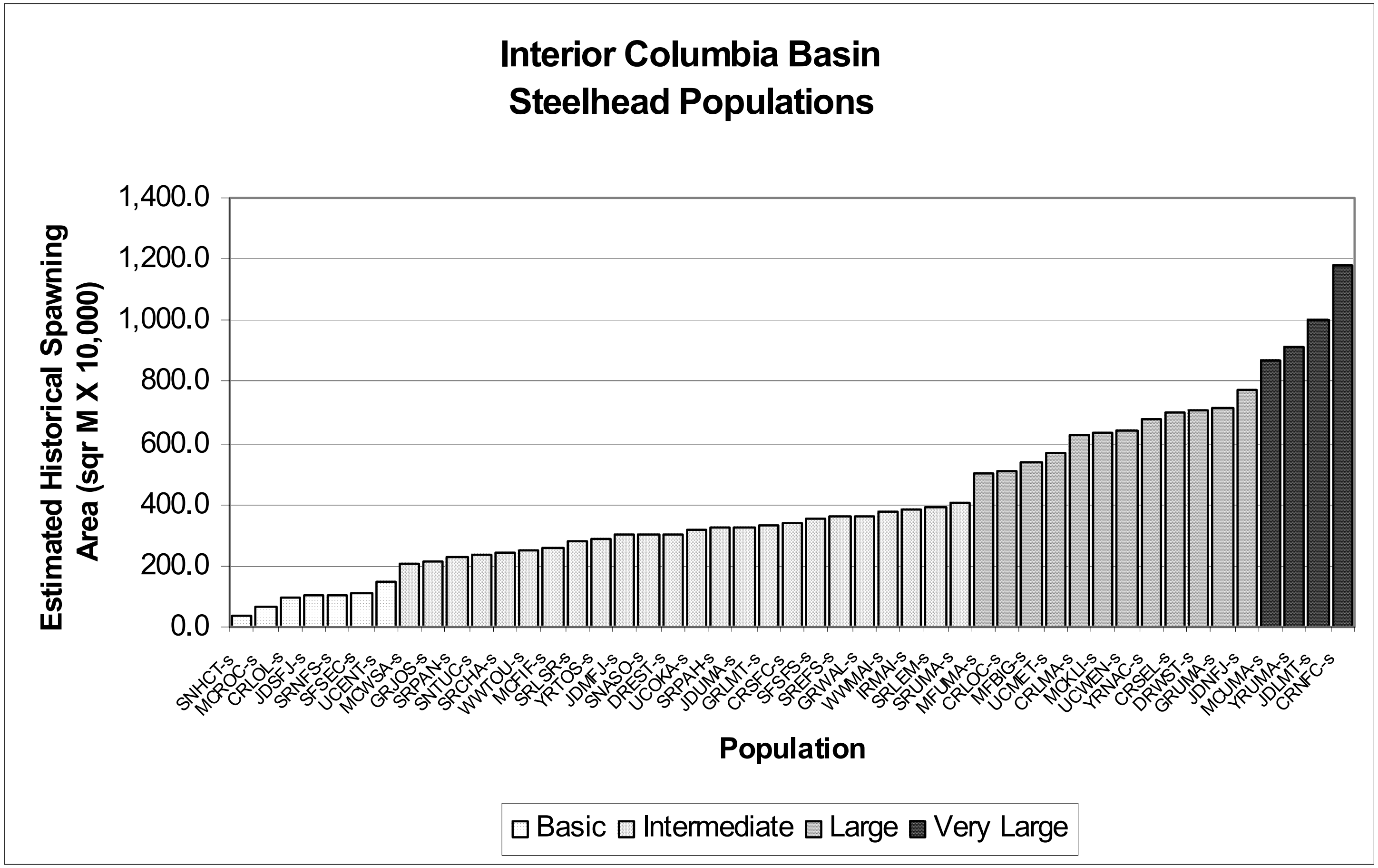


Table B-3 Steelhead populations (Upper Columbia, Middle Columbia and Snake River ESUs). Summary statistics for population size and complexity assessments. Estimates based on historical intrinsic potential analysis.

Steelhead Populations	**Tributary Spawning Habitat - Capacity Categories**			
	Basic	***Intermediate***	***Large***	***Very Large***
Number of Populations in the category	**7**	**24**	**12**	**4**
Spawning Area (X 10,000 m2) ***Median***	***102.7***	***302.3***	***626.6***	***983.4***
Range	*(68.5 - 145.7)*	*(206. 8 - 404.1)*	*(503.1 - 771.1)*	*(869.3 - 1179.0)*
Number of Major Spawning Areas per population ***Median***	***1***	***2.5***	***6***	***11***
Range	*(1 - 4)*	*(2 - 6)*	*(4 - 6)*	*(10 -14)*